Party #1/C

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<110> Gotschlich, Emil C.

<120> GLYCOSYLTRANSFERASES FOR BIOSYNTHESIS OF OLIGOSACCHARIDES, AND GENES ENCODING THEM

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<141> 2001-12-03

<150> US 09/333,412
<151> 1999-06-15

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<151> 1997-06-18

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<151> 1996-07-18

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35 40 45

Ala Leu Tyr Ala Ala Ala Gln Gly Leu Gln Pro Lys Ile Ala Ala Ala
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Val Ala Glu Gly Asn Phe Arg Thr Ala Leu Ser Glu Leu Ala Ser Val
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Lys Pro Gln Val Asp Ala Phe Phe Asp Gly Val Met Val Met Ala Glu
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Asp Ala Ala Val Lys Gln Asn Arg Leu Asn Leu Leu Asn Arg Leu Ala
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Leu Asp Ile Leu Ile Val Asp Asp Gly Ser Thr Asp Gly Thr Leu Ala
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Ile Ala Lys Asp Phe Gln Lys Arg Asp Ser Arg Ile Lys Ile Leu Ala
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Gln Ala Gln Asn Ser Gly Leu Ile Pro Ser Leu Asn Ile Gly Leu Asp
65                  70                  75                  80

Glu Leu Ala Lys Ser Gly Gly Gly Gly Gly Glu Tyr Ile Ala Arg Thr
                85                  90                  95

Asp Ala Asp Asp Ile Ala Ser Pro Gly Trp Ile Glu Lys Ile Val Gly
            100                 105                 110

Glu Met Glu Lys Asp Arg Ser Ile Ile Ala Met Gly Ala Trp Leu Glu
        115                 120                 125

Val Leu Ser Glu Glu Lys Asp Gly Asn Arg Leu Ala Arg His His Lys
    130                 135                 140

His Gly Lys Ile Trp Lys Lys Pro Thr Arg His Glu Asp Ile Ala Ala
145                 150                 155                 160

Phe Phe Pro Phe Gly Asn Pro Ile His Asn Asn Thr Met Ile Met Arg
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Arg Ser Val Ile Asp Gly Gly Leu Arg Tyr Asp Thr Glu Arg Asp Trp
            180                 185                 190

Ala Glu Asp Tyr Gln Phe Trp Tyr Asp Val Ser Lys Leu Gly Arg Leu
        195                 200                 205

Ala Tyr Tyr Pro Glu Ala Leu Val Lys Tyr Arg Leu His Ala Asn Gln
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Val Ser Ser Lys His Ser Val Arg Gln His Glu Ile Ala Gln Gly Ile
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Gln Lys Thr Ala Arg Asn Asp Phe Leu Gln Ser Met Gly Phe Lys Thr
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Arg Phe Asp Ser Leu Glu Tyr Arg Gln Thr Lys Ala Ala Ala Tyr Glu
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Phe Leu Tyr Gln Cys Phe Lys Arg Thr Asp Thr Pro Pro Ser Gly Ala
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Trp Leu Asp Phe Ala Ala Asp Gly Arg Met Arg Arg Leu Phe Thr Leu
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Phe His Val Leu Asp Ala Gly Ile Ser Glu Glu Asn Arg Ala Ala Val
35 40 45

Ala Ala Asn Leu Arg Gly Gly Gly Asn Ile Arg Phe Ile Asp Val Asn
50 55 60

Pro Glu Asp Phe Ala Gly Phe Pro Leu Asn Ile Arg His Ile Ser Ile
65 70 75 80

Thr Thr Tyr Ala Arg Leu Lys Leu Gly Glu Tyr Ile Ala Asp Cys Asp
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Lys Val Leu Tyr Leu Asp Thr Asp Val Leu Val Arg Asp Gly Leu Lys
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Pro Leu Trp Asp Thr Asp Leu Gly Gly Asn Trp Val Gly Ala Cys Ile
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Asp Leu Phe Val Glu Arg Gln Glu Gly Tyr Lys Gln Lys Ile Gly Met
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Lys Lys Trp Arg Arg His Asp Ile Phe Lys Met Ser Cys Glu Trp Val
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Glu Gln Tyr Lys Asp Val Met Gln Tyr Gln Asp Gln Asp Ile Leu Asn
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Gly Leu Phe Lys Gly Gly Val Cys Tyr Ala Asn Ser Arg Phe Asn Phe
        195                 200                 205

Met Pro Thr Asn Tyr Ala Phe Met Ala Asn Gly Phe Ala Ser Arg His
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Thr Asp Pro Leu Tyr Leu Asp Arg Thr Asn Thr Ala Met Pro Val Ala
225                 230                 235                 240

Val Ser His Tyr Cys Gly Ser Ala Lys Pro Trp His Arg Asp Cys Thr
                245                 250                 255

Val Trp Gly Ala Glu Arg Phe Thr Glu Leu Ala Gly Ser Leu Thr Thr
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Val Pro Glu Glu Trp Arg Gly Lys Leu Ala Val Pro Pro Thr Lys Cys
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Leu Asp Ile Leu Ile Val Asp Asp Gly Ser Thr Asp Gly Thr Pro Ala
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Ile Ala Arg His Phe Gln Glu Gln Asp Gly Arg Ile Arg Ile Ile Ser
    50                  55                  60

Asn Pro Arg Asn Leu Gly Phe Ile Ala Ser Leu Asn Ile Gly Leu Asp
65                  70                  75                  80

Glu Leu Ala Lys Ser Gly Gly Gly Glu Tyr Ile Ala Arg Thr Asp Ala
                85                  90                  95

Asp Asp Ile Ala Ser Pro Gly Trp Ile Glu Lys Ile Val Gly Glu Met
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Glu Lys Asp Arg Ser Ile Ile Ala Met Gly Ala Trp Leu Glu Val Leu
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Ala Ile Trp Asp Lys Pro Thr Arg His Glu Asp Ile Val Ala Val Phe
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Pro Phe Gly Asn Pro Ile His Asn Asn Thr Met Ile Met Arg Arg Ser
                165                 170                 175

Val Ile Asp Gly Gly Leu Arg Phe Asp Pro Ala Tyr Ile His Ala Glu
            180                 185                 190

Asp Tyr Lys Phe Trp Tyr Glu Ala Gly Lys Leu Gly Arg Leu Ala Tyr
        195                 200                 205

Tyr Pro Glu Ala Leu Val Lys Tyr Arg Phe His Gln Asp Gln Thr Ser
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Ser Lys Tyr Asn Leu Gln Gln Arg Arg Thr Ala Trp Lys Ile Lys Glu
225                 230                 235                 240

Glu Ile Arg Ala Gly Tyr Trp Lys Ala Ala Gly Ile Ala Val Gly Ala
                245                 250                 255

Asp Cys Leu Asn Tyr Gly Leu Leu Lys Ser Thr Ala Tyr Ala Leu Tyr
            260                 265                 270

Glu Lys Ala Leu Ser Gly Gln Asp Ile Gly Cys Leu Arg Leu Phe Leu
        275                 280                 285

Tyr Glu Tyr Phe Leu Ser Leu Glu Lys Tyr Ser Leu Thr Asp Leu Leu
    290                 295                 300

Asp Phe Leu Thr Asp Arg Val Met Arg Lys Leu Phe Ala Ala Pro Gln
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Tyr Arg Lys Ile Leu Lys Lys Met Leu Arg Pro Trp Lys Tyr Arg Ser
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Asp Ala Leu Met Pro Ser Glu Arg Leu Glu Gln Ala Met Ala Glu Leu
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Val Pro Gly Leu Ser Ala His Pro Tyr Leu Ser Gly Val Glu Lys Ala
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Cys Phe Met Ser His Ala Val Leu Trp Glu Gln Ala Leu Asp Glu Gly
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Leu Pro Tyr Ile Ala Val Phe Glu Asp Asp Val Leu Leu Gly Glu Gly
                85                  90                  95

Ala Glu Gln Phe Leu Ala Glu Asp Thr Trp Leu Glu Glu Arg Phe Asp
            100                 105                 110

Lys Asp Ser Ala Phe Ile Val Arg Leu Glu Thr Met Phe Ala Lys Val
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Ile Val Arg Pro Asp Lys Val Leu Asn Tyr Glu Asn Arg Ser Phe Pro
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Leu Leu Glu Ser Glu His Cys Gly Thr Ala Gly Tyr Ile Ile Ser Arg
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Glu Ala Met Arg Phe Phe Leu Asp Arg Phe Ala Val Leu Pro Pro Glu
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Arg Ile Lys Ala Val Asp Leu Met Met Phe Thr Tyr Phe Phe Asp Lys
            180                 185                 190

Glu Gly Met Pro Val Tyr Gln Val Ser Pro Ala Leu Cys Thr Gln Glu
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Leu His Tyr Ala Lys Phe Leu Ser Gln Asn Ser Met Leu Gly Ser Asp
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Leu Glu Lys Asp Arg Glu Gln Gly Arg Arg His Arg Arg Ser Leu Lys
225                 230                 235                 240

Val Met Phe Asp Leu Lys Arg Ala Leu Gly Lys Phe Gly Arg Glu Lys
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Gly Arg Arg Val Ile Leu Phe Lys
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<212> PRT
<213> Neisseria gonorrheae

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His Ile Ala Ala Thr Phe Gly Ser Arg Gly Ile Pro Phe Gln Phe Phe
20 25 30

Asp Ala Leu Met Pro Ser Glu Arg Leu Glu Arg Ala Met Ala Glu Leu
35 40 45

Val Pro Gly Leu Ser Ala His Pro Tyr Leu Ser Gly Val Glu Lys Ala
50 55 60

Cys Phe Met Ser His Ala Val Leu Trp Glu Gln Ala Leu Asp Glu Gly
65 70 75 80

Val Pro Tyr Ile Ala Val Phe Glu Asp Asp Val Leu Leu Gly Glu Gly
85 90 95

Ala Glu Gln Phe Leu Ala Glu Asp Thr Trp Leu Gln Glu Arg Phe Asp
100 105 110

Pro Asp Ser Ala Phe Val Val Arg Leu Glu Thr Met Phe Met His Val
115 120 125

Leu Thr Ser Pro Ser Gly Val Ala Asp Tyr Gly Gly Arg Ala Phe Pro
130 135 140

Leu Leu Glu Ser Glu His Cys Gly Thr Ala Gly Tyr Ile Ile Ser Arg
145 150 155 160

Lys Ala Met Arg Phe Phe Leu Asp Arg Phe Ala Val Leu Pro Pro Glu
165 170 175

Arg Leu His Pro Val Asp Leu Met Met Phe Gly Asn Pro Asp Asp Arg
180 185 190

Glu Gly Met Pro Val Cys Gln Leu Asn Pro Ala Leu Cys Ala Gln Glu
195 200 205

Leu His Tyr Ala Lys Phe His Asp Gln Asn Ser Ala Leu Gly Ser Leu
210 215 220

Ile Glu His Asp Arg Arg Leu Asn Arg Lys Gln Gln Trp Arg Asp Ser
225 230 235 240

Pro Ala Asn Thr Phe Lys His Arg Leu Ile Arg Ala Leu Thr Lys Ile
245 250 255

Gly Arg Glu Arg Glu Lys Arg Arg Gln Arg Arg Glu Gln Leu Ile Gly
260 265 270

Lys Ile Ile Val Pro Phe Gln
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<210> 9
<211> 21
<212> DNA
<213> Artificial Sequence

<220>
<223> PCR primer

<400> 9
gccgagaaaa ctattggtgg a 21

<210> 10
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<212> DNA
<213> Artificial Sequence

<220>
<223> PCR primer

<400> 10
aaaacatgca ggaattgacg at 22

<210> 11
<211> 348
<212> PRT
<213> non-Neisseria

<400> 11

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Leu Gln Pro Leu Val Ser Val Leu Ile Cys Ala Tyr Asn Val Glu Lys
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Tyr Phe Ala Gln Ser Leu Ala Ala Val Val Asn Gln Thr Trp Arg Asn
            20                  25                  30

Leu Asp Ile Leu Ile Val Asp Asp Gly Ser Thr Asp Gly Thr Leu Ala
        35                  40                  45

Ile Ala Lys Asp Phe Gln Lys Arg Asp Ser Arg Ile Lys Ile Leu Ala
    50                  55                  60

Gln Ala Gln Asn Ser Gly Leu Ile Pro Ser Leu Asn Ile Gly Leu Asp
65                  70                  75                  80

Glu Leu Ala Lys Ser Gly Gly Gly Gly Gly Glu Tyr Ile Ala Arg Thr
                85                  90                  95

Asp Ala Asp Asp Ile Ala Ser Pro Gly Trp Ile Glu Lys Ile Val Gly
            100                 105                 110

Glu Met Glu Lys Asp Arg Ser Ile Ile Ala Met Gly Ala Trp Leu Glu
        115                 120                 125

Val Leu Ser Glu Glu Lys Asp Gly Asn Arg Leu Ala Arg His His Lys
    130                 135                 140

His Gly Lys Ile Trp Lys Lys Pro Thr Arg His Glu Asp Ile Ala Ala
145                 150                 155                 160

Phe Phe Pro Phe Gly Asn Pro Ile His Asn Asn Thr Met Ile Met Arg
                165                 170                 175

Arg Ser Val Ile Asp Gly Gly Leu Arg Tyr Asp Thr Glu Arg Asp Trp
            180                 185                 190

Ala Glu Asp Tyr Gln Phe Trp Tyr Asp Val Ser Lys Leu Gly Arg Leu
        195                 200                 205

Ala Tyr Tyr Pro Glu Ala Leu Val Lys Tyr Arg Leu His Ala Asn Gln
    210                 215                 220

Val Ser Ser Lys His Ser Val Arg Gln His Glu Ile Ala Gln Gly Ile
225                 230                 235                 240

Gln Lys Thr Ala Arg Asn Asp Phe Leu Gln Ser Met Gly Phe Lys Thr
                245                 250                 255

Arg Phe Asp Ser Leu Glu Tyr Arg Gln Thr Lys Ala Ala Ala Tyr Glu
            260                 265                 270

Leu Pro Glu Lys Asp Leu Pro Glu Glu Asp Phe Glu Arg Ala Arg Arg
        275                 280                 285

Phe Leu Tyr Gln Cys Phe Lys Arg Thr Asp Thr Pro Pro Ser Gly Ala
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290 295 300

Trp Leu Asp Phe Ala Ala Asp Gly Arg Met Arg Arg Leu Phe Thr Leu
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Arg Gln Tyr Phe Gly Ile Leu Tyr Arg Leu Ile Lys Asn Arg Arg Gln
325 330 335

Ala Arg Ser Asp Ser Ala Gly Lys Glu Gln Glu Ile
340 345

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<211> 337
<212> PRT
<213> non-Neisseria

<400> 12

Leu Gln Pro Leu Val Ser Val Leu Ile Cys Ala Tyr Asn Ala Glu Lys
1 5 10 15

Tyr Phe Ala Gln Ser Leu Ala Ala Val Val Gly Gln Thr Trp Arg Asn
20 25 30

Leu Asp Ile Leu Ile Val Asp Asp Gly Ser Thr Asp Gly Thr Pro Ala
35 40 45

Ile Ala Arg His Phe Gln Glu Gln Asp Gly Arg Ile Arg Ile Ile Ser
50 55 60

Asn Pro Arg Asn Leu Gly Phe Ile Ala Ser Leu Asn Ile Gly Leu Asp
65 70 75 80

Glu Leu Ala Lys Ser Gly Gly Gly Glu Tyr Ile Ala Arg Thr Asp Ala
85 90 95

Asp Asp Ile Ala Ser Pro Gly Trp Ile Glu Lys Ile Val Gly Glu Met
100 105 110

Glu Lys Asp Arg Ser Ile Ile Ala Met Gly Ala Trp Leu Glu Val Leu
115 120 125

Ser Glu Glu Asn Asn Lys Ser Val Leu Ala Ala Ile Ala Arg Asn Gly
130 135 140

Ala Ile Trp Asp Lys Pro Thr Arg His Glu Asp Ile Val Ala Val Phe
145 150 155 160

Pro Phe Gly Asn Pro Ile His Asn Asn Thr Met Ile Met Arg Arg Ser
165 170 175

Val Ile Asp Gly Gly Leu Arg Phe Asp Pro Ala Tyr Ile His Ala Glu
180 185 190

Asp Tyr Lys Phe Trp Tyr Glu Ala Gly Lys Leu Gly Arg Leu Ala Tyr
195 200 205

```
Tyr Pro Glu Ala Leu Val Lys Tyr Arg Phe His Gln Asp Gln Thr Ser
    210                 215                 220

Ser Lys Tyr Asn Leu Gln Gln Arg Arg Thr Ala Trp Lys Ile Lys Glu
225                 230                 235                 240

Glu Ile Arg Ala Gly Tyr Trp Lys Ala Ala Gly Ile Ala Val Gly Ala
                245                 250                 255

Asp Cys Leu Asn Tyr Gly Leu Leu Lys Ser Thr Ala Tyr Ala Leu Tyr
            260                 265                 270

Glu Lys Ala Leu Ser Gly Gln Asp Ile Gly Cys Leu Arg Leu Phe Leu
        275                 280                 285

Tyr Glu Tyr Phe Leu Ser Leu Glu Lys Tyr Ser Leu Thr Asp Leu Leu
    290                 295                 300

Asp Phe Leu Thr Asp Arg Val Met Arg Lys Leu Phe Ala Ala Pro Gln
305                 310                 315                 320

Tyr Arg Lys Ile Leu Lys Lys Met Leu Arg Pro Trp Lys Tyr Arg Ser
                325                 330                 335

Tyr
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<210> 13
<211> 306
<212> PRT
<213> Escherichia coli

<400> 13

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Leu Asp Ile Ala Tyr Gly Thr Asp Lys Asn Phe Leu Phe Gly Cys Gly
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Ile Ser Ile Ala Ser Ile Leu Lys Tyr Asn Glu Gly Ser Arg Leu Cys
            20                  25                  30

Phe His Ile Phe Thr Asp Tyr Phe Gly Asp Asp Asp Arg Lys Tyr Phe
        35                  40                  45

Asp Ala Leu Ala Leu Gln Tyr Lys Thr Arg Ile Lys Ile Tyr Leu Ile
    50                  55                  60

Asn Gly Asp Arg Leu Arg Ser Leu Pro Ser Thr Lys Asn Trp Thr His
65                  70                  75                  80

Ala Ile Tyr Phe Arg Phe Val Ile Ala Asp Tyr Phe Ile Asn Lys Ala
                85                  90                  95

Pro Lys Val Leu Tyr Leu Asp Ala Asp Ile Ile Cys Gln Gly Thr Ile
            100                 105                 110

Glu Pro Leu Ile Asn Phe Ser Phe Pro Asp Asp Lys Val Ala Met Val
        115                 120                 125
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Val Thr Glu Gly Gln Ala Asp Trp Trp Glu Lys Arg Ala His Ser Leu
    130                 135                 140

Gly Val Ala Gly Ile Ala Lys Gly Tyr Phe Asn Ser Gly Phe Leu Leu
145                 150                 155                 160

Ile Asn Thr Ala Gln Trp Ala Ala Gln Gln Val Ser Ala Arg Ala Ile
                165                 170                 175

Ala Met Leu Asn Glu Pro Glu Ile Ile Lys Lys Ile Thr His Pro Asp
            180                 185                 190

Gln Asp Val Leu Asn Met Leu Leu Ala Asp Lys Leu Ile Phe Ala Asp
        195                 200                 205

Ile Lys Tyr Asn Thr Gln Phe Ser Leu Asn Tyr Gln Leu Lys Glu Ser
    210                 215                 220

Phe Ile Asn Pro Val Thr Asn Asp Thr Ile Phe Ile His Tyr Ile Gly
225                 230                 235                 240

Pro Thr Lys Pro Trp His Asp Trp Ala Trp Asp Tyr Pro Val Ser Gln
                245                 250                 255

Ala Phe Met Glu Ala Lys Asn Ala Ser Pro Trp Lys Asn Thr Ala Leu
            260                 265                 270

Leu Lys Pro Asn Asn Ser Asn Gln Leu Arg Tyr Ser Ala Lys His Met
        275                 280                 285

Leu Lys Lys His Arg Tyr Leu Lys Gly Phe Ser Asn Tyr Leu Phe Tyr
    290                 295                 300

Phe Ile
305
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